ECO HOME MONITORING SYSTEM

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ABSTRACT

Smart home is known among people as a luxurious set of gadgets that affordable only for elite group residence. The increase in house breaking cases trigger the need for a smart home security system for all houses. Therefore, with the rapid changing in information and communication technology (ICT), a web base system that called Economic Home Monitoring System or Eco Home Monitoring System is developed to control electrical home appliances by using Single Board Computer (SBC). By using one module of SBC that integrated by GPIO port for controlling the sensors in the electrical home devices, can tighten up the security, saving time and money. At the same time, the Eco Home Monitoring System also integrated with home camera system and home security system, which able the user to monitoring surrounding house are thru their smart smartphone, tablets, and personal computer. This Eco Home Monitoring System is user friendly, affordable and the important thing it is secure system.

ABSTRAK

Rumah pintar dikenali di kalangan masyarakat sebagai satu set alat mewah yang mampu dimiliki hanya untuk kediaman kumpulan elit. Peningkatan kes-kes pecah rumah menjadikan satu keperluan untuk pembangunan sistem rumah pintar untuk keselamatan semua rumah. Oleh itu, dengan perubahan pesat dalam teknologi maklumat dan komunikasi (ICT), satu sistem asas web yang dipanggil “Economic Home Monitoring System” atau “Eco Home Monitoring System” dibangunkan untuk mengawal peralatan elektrik rumah dengan menggunakan “single board computer” (SBC). Dengan menggunakan satu modul SBC yang mempunyai GPIO port untuk mengawal sensor dalam peranti elektrik di sesebuah rumah, malahan juga boleh meningkatkan tahap keselamatan serta menjimatkan masa dan wang. Pada masa yang sama, “Eco Home Monitoring System” juga bersambung dengan sistem kamera rumah dan sistem keselamatan rumah, yang mampu membantu pengguna untuk memantau persekitaran rumah melalui telefon pintar, tablet, dan komputer peribadi. Selain itu, “Eco Home Monitoring System” adalah mesra pengguna, mampu milik dan yang paling penting ia adalah satu sistem yang selamat.

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CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

The terms smart home, home networking, home automation, intelligent home have been used for more decade to introduce the concept of networking devices and equipment in the house. According to the Smart Homes Association the best definition of smart home technology is the integration of technology and services through home networking for a better quality of living [1].

Other terms that are related to smart homes are changeable home, aware house, ambient intelligence and attentive house. These terms are used to emphasize that the home environment should be able to respond and modify itself continuously according to its diverse residents and their changeable needs. For instance ambient intelligence is defined as a digital environment that is sensitive, adaptive and responsive to the presence of people [2]. Ambient intelligent will encompass the home, car, clothing, work and public places.

Smart home is known amongst people as a luxurious set of gadgets affordable only for elite group residence. The needs of home automation system probably will increase as the occurrences of housebreaking may involve any group of people. Therefore, with the new rapid changing in ICT, a web base system that is Eco Home Monitoring System could be develop to control the electrical home devices for our homes.

The Eco Home Control and Monitoring System is a control system by using a web based system to control the devices in the house. User will be able to turn on and off the device using a web browser. Other than that, user also can monitor the house via camera. For the security in the house, user can turn on the magnetic door switch to give an alert and sending an email to the user. This system also integrates with a few sensors like a motion, temperature, and light sensor. This system will uses to control and monitoring the home appliance which is located anywhere and everywhere in the house.

1.2 PROBLEM STATEMENT

- There are no controller and monitoring system using single board computer.
- There are no integration of controlling and monitoring with security system.
- Waste money to buy remote sensor to control with each devices.
- Waste electricity and time due to if we forget to turn off the switch.

1.3 OBJECTIVE

The objectives of this project are:

I. To design and develop a controller and monitoring system using a single board computer.

II. To verify that a web base system that can be integrate with GPIO port for controlling home electrical appliances and sensor due to save money and time.

III. To ensure that Eco Home Monitoring System will be useable towards users.

1.4 SCOPE

This study focused on home automation system architecture that will be useful to Malaysian market. The target group of this Eco Home Monitoring System probably for various group of income level.

The cost is more affordable than previous system available in the market. Prototype of this study will be developing within the period of two semesters. The development will focused on one module which is the Raspberry Pi on controlling the home appliances such as the lamps, fans, gate, sensor, camera, etc.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The objectives of this study are to introduce the raspberry pi competency in home automation system. Home automation system being known in the market as an expensive system, so not everybody can afford these devices. However, as the rapid growth of the technology increased the popularity of home automation began in the market positively. Therefore, the study of an eco-home automation system is being introduced to develop a product that will be affordable to the middle class income level. Before we proceed the architecture of Raspberry Pi and other devices, we need to review the current literature review on the related issues of home automation system. In this chapter, a literature review in support of the study will be carried out in the following 4 areas;

2.2 Overview of home automation
2.3 The benefits of home automation
2.4 The existing system
2.5 The problems with the current systems
2.6 Comparison of technologies

The literature review covers only the most relevant aspects of home automation in order to introduce the new technology used for home automation system.

2.2 OVERVIEW OF HOME AUTOMATION

2.2.1 HOME AUTOMATION TERMINOLOGY

Home automation technologies have remained out of reach of the mainstream consumers for a long time [3]. The high cost and custom installer requirements have restricted them to high end homes. The multitude of technologies in this space has also been detrimental to the adaption rate [3]. However the rise of smartphone and tables has suddenly brought about a big shift in the landscape.

Consistently the word ‘Automation’, ‘Home Automation’, ‘Smart Home’ or ‘Intelligent Homes’ every time is mentioned gives out the impression of exaggeration, luxurious desires or as show-off for their homes, through unlikely and in wise terms this is a simplification of the basic or so common functions around the house.

In home automation terminology, ‘scenes’ refer to the linking of devices in intelligent ways based on events [3]. Simple device-based control using a mobile app opens the door. But, one also needs a central device which can perform the orchestration [3].

2.2.2 THE HISTORY OF HOME AUTOMATION

Home automation system is not new in the market. In fact, it has been here for many years. The home automation technology has been introduced to the world for the last 30 years. However, for us the Malaysian market is thinking that to implement the home automation system in the house is very expensive. But, if the system more affordable, more people will purchase the devices and gadgets.

Despite interest in home automation, by the end of the 1990s there was not a widespread uptake with such systems still considered the domain of hobbyists or the rich. The lack of a single, simplified, protocol and high cost of entry has put off consumers [4].

2.3 THE BENEFITS OF HOME AUTOMATION

With home automation, we can experience a life of convenience and security. Other than that, we have the ability to control the small appliances and lighting, again with the simple tap of finger on favorite technological device such as smartphones and tablets. Not only to make sure that the lights are off when we are gone to save electricity, it also allows to turn them on at specific times if we would like it to look like someone are at home. This also helps increase the safety and security of our home.

Unfortunately, we just cannot be everywhere at once. This means that we often miss things that happen, perhaps even in our own home. With a home automation system, we can easily see what is happening at our home. Now we can me sure no unwelcome guest arrive unbeknownst to our home [5]. Security camera increase family safety by capturing clips when detecting movement or at specific times of the day or night.

2.4 EXISTING SYSTEM

Home automation system plays an important role in the modern life where concerned of safety is one of the foremost thoughts right after comfort. Many of studies have been conducted to develop the products at once to promote the benefits of this home automation system. There are a two existing system of home automation has been developed using various kind of technology:-

2.4.1 X10

Figure 2.1: X10 Lamp Module

X10 is the standard used to control other X10 connected devices using the building's built in eletctrical system to transmit the signals [6]. Lights and devices can be plugged into X10 modules such as the ones sold by Habitek [7]. The modules are the interface between devices and the power lines which receive the commands from an X10 control devices. This can be basic device such as a remote control [8]. Delivering X10 command to the relevant X10 modules or a controller that is software based and runs on some sort of computer. An example of such software is X10 Controller [9]. It uses a graphical user interface to control X10 modules both locally on the computer and across the web. It runs as windows

service which allows command to be issued when the computer is on, but the user isn't logged on [9].

2.4.1.1 HOW X10 IS USED TO SEND COMMANDS

The theory of transmitting commands to the X10 devices consists of transmitting byte codes along a power line. To connect devices to a computer we need to use a two-way interface called CM12U (this is the U.K 240v version of 110v CM11A which will see widely used in home automation in the US [10]) connect to the Computer and then to the power line.

AC (alternating current) is the current that we have in our homes in the Malaysia. AC has a "current that changes polarity or direction, respectively, over time [11]" This type of current forms a sine wave as shown in Figure 2. Commands are sent along the power lines and "transmissions are synchronized to the zero crossing point of the AC power line".

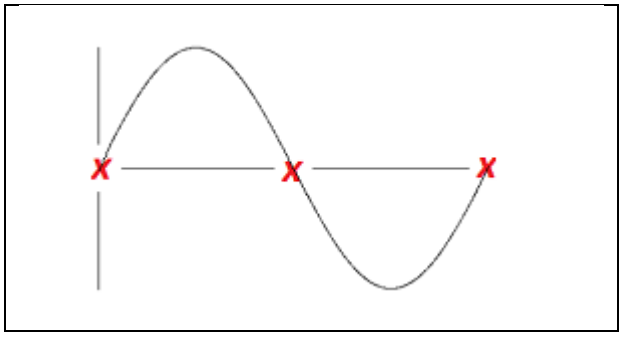

Figure 2.2: Sine Wave

The zero crossing points are when the sine curve crosses the x axes (as marked by the red crosses above). The transmitter provides a square sine wave [12].

"The rate of changing direction (from positive to negative) is called the frequency of the Alternating Current and is measured in hertz (Hz)" [13]. In the Malaysia our electricity is delivered to our homes with a frequency of 50Hz [13]. This mean that one cycle/sine wave take 1/50 seconds, which is 20 milliseconds.

X10 transmission is sent at the zero crossing point of the AC Sine Wave. The aim should be to transmit the data with a 200 microsecond threshold of the zero crossing point [12].

2.4.1.2 X10 DEVICE COMMANDS

X10 Device Commands consist of a bit "Start Code", followed by a "House Code" (denoted by letters A-P but transmitted in Binary), then followed by either a "Device Code" (denoted by number 1-16 but transmitted in Binary) or by a "Function Code", then followed by a "Function" bit which is tagged on to the end of the Device/Function code to let the X10 modules know whether it is an addressing command or a function command [13]

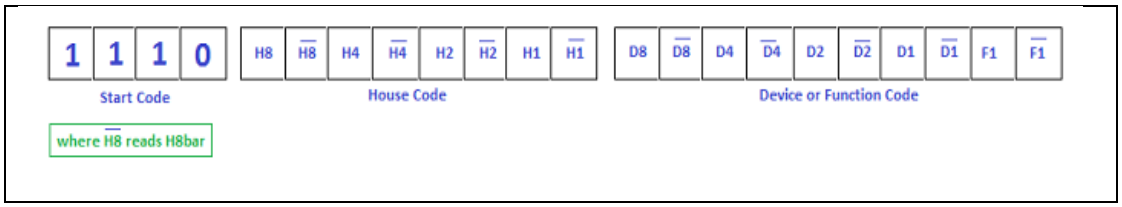

Figure 2.3: X10 Transmission Format

We first send a message consisting of the Start Code, House Code and Device Code. The next message we need to send consists of the Start Code, House Code and Function. Each message is sent in full twice, with at least three power line cycles

between each message [11].This does not apply with the dimming commands as then the message are sent continuously.

For example if we want to transmit the verbal command “turn on Device 1, in House A” we would send the following:

The house code for A is: 0110 The Device code for 1 is: 01100 The Function Code for On is: 00101

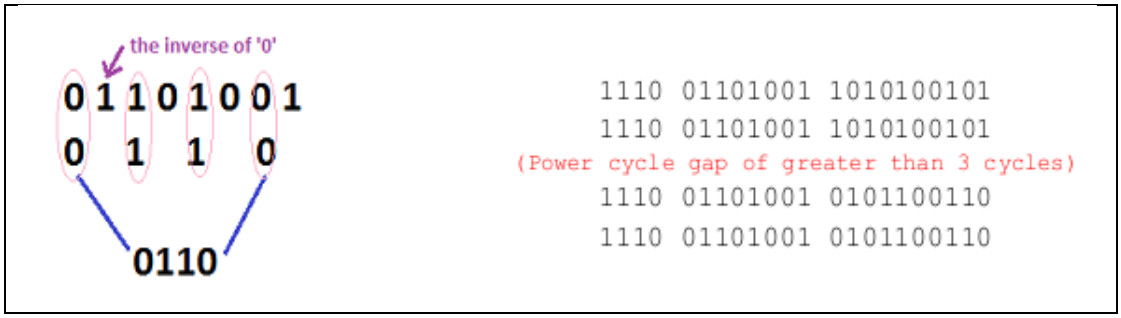

Figure 2.4: Decoding True bit and complement bit codes

2.4.2 INSTEON

Figure 2.5: Insteon Home Automation modules

Insteon is brand name for another alternative to X10. Insteon uses modules between each device and the power line. Each module acts as both a transmitter and a receiver, so no dedicated transmitter modules are required. Insteon technology is that it is backwards compatible with X10. People who already own X10 devices can use them in their Insteon network without the need to replace them. Developers at Insteon have looked more deeply into devices and looking at how they can control air-conditioning and heating system relatively easily, taking the home automation arguably to the next step past X10. The reason they wanted to develop this product was that they thought that there were reliability issues with X10 and wanted to improve on the X10 technology.

2.4.2.1 HOW INSTEON SENDS COMMANDS

Insteon devices like X10 have to message methods, a standard and an extended message. The standard message length for Insteon is 10 byte.

INSTEON Standard Message – 10 Bytes				
3 Bytes	3 Bytes	1 Byte	2 Bytes	1 Byte
From Address	To Address	Flags	Command 1, 2	CRC[3]

Table 2.1: Insteon Standard Message Structure

The Insteon messages are much larger than X10 message, they are as minimum 80bits (10 bytes) but 14 byte longer for extended messages. It does however mean that both the message and the command are stored together and sent together rather than in two separate messages as they are in X10.

2.5 PROBLEMS WITH THE CURRENT SYSTEM

The first clear disadvantages to some of the systems are cost. If money is not object then we can get some really great systems, but seeing as this is not the case for many people, budget is a key factor. If a product is to become successful it needs to be financial accessible to the mass market. X10 and Insteon system are not an option for a lot of people, therefore affordable plug and play and easily configurable solutions need developing, even if they do have slightly less functionality than the X10 and Insteon system.

The problem with current home automation system is that the home automation standards are extremely fragmented [11]. The problem with this is there is no universal

standard, and lots of protocols and devices are proprietary and this makes it harder for new system to be developed as quickly as we would like [12].

2.6 COMPARISON OF TECHNOLOGIES

Insteon and X10 are both designed to achieve very similar goals. Insteon offers a broader scope for development in the future and its mesh network topology should make the system more reliable of the two. Insteon is not currently available for sale in the Malaysia yet. Insteon prices in the US are considerably more expensive [13], but as Insteon is not sale in the Malaysia, it is hard to make a direct comparison.

2.7 SUMMARY

Form my research I then concluded with the main technologies that I will use in my own home automation system. I will use Raspberry Pi in my system as it is a relatively simple protocol that is ideal for developing a home automation system in the time scale I have. Python will be used as the main language for my system due to its multi-platform compatibility with Raspberry Pi.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter will discuss about the methodology use to complete this project. It will involve the planning, analyzing, preparation, designing, coding, testing and maintaining. The methodology that will be used is the Rapid Application Development (RAD). RAD makes the development process to be more credible one by facilitating a scope for the customer to actively provide inputs and feedback in the development process. This may also prove feasible from the point of view of a developer.

RAD is chosen for this project because RAD focused on building system rapidly in a very short amount of time and it is flexible and adaptable to change. RAD is suitable for this project because this project requires maintenance. This project will have a hardware and software. The system will communicate with the Raspberry Pi to the relay board and the sensors.

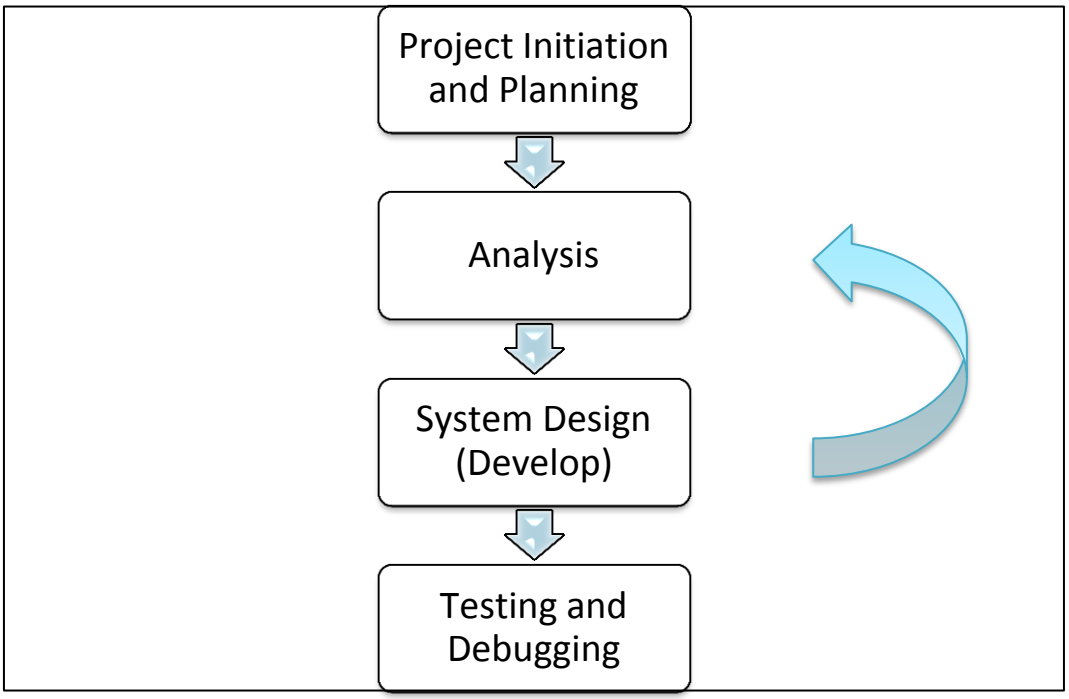

Figure 3.1: RAD Cycle

Advantages of Rapid Application Development (RAD)

- Flexible and Adaptable to change
- RAD realizes an overall reduction in project risk
- Can handle large project without problem
- Minimizes feature creep by developing in short intervals resulting in miniature software projects and releasing the product in mini-increments.
- Speed up the development by re-usability components
- Quality will be increases